PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

APPLICANT: BRUNNER ET AL - 1 (CPA) EXAMINER: C. A. BROWN

SERIAL NO: 09/425,694 GROUP: 1765

FILED: OCTOBER 22, 1999

TITLE: PROCESS FOR THE WET TREATMENT OF SEMICONDUCTOR WAFERS

ATTN: BOX AFTER FINAL
Assistant Commissioner of Patents
Washington, D.C. 20231

RESPONSE TO FINAL OFFICE ACTION

This is in response to the Final Office Action dated November 14, 2002.

REMARKS

Reconsideration of this patent application is respectfully requested in view of the following remarks.

The Patent Examiner has rejected claims 1 to 11 as being unpatentable under 35 U.S.C. 103 over *Pirooz EP 701,275* in view *Verhaverbeke U.S. Patent No. 6,132,522*. (It is respectfully submitted that *Pirooz* is not EP0731498A2 which is *Fukuzawa)*.

Neither *Pirooz*, nor *Verhaverbeke*, teach or suggest the claimed three steps of firstly treating the semiconductor wafers

in a bath with an aqueous HF solution; only containing HF;

then treating the semiconductor wafers in a bath with an aqueous O_3 solution; only containing O_3,; and

then treating the semiconductor wafers in a bath with an aqueous HCl solution; only containing HCl;

whereby these treatment steps form a treatment sequence B_2, which avoids rinsing with water or another treatment liquid and the addition of fresh water or other liquids to the treatment baths.

In this Final Office Action, it is respectfully submitted that the Patent Examiner does not refer in a comprehensive way to the arguments that were presented in the Amendment filed August 14, 2002. For example, there is no comment on the differences between the claimed invention and *Verhaverbeke et al.*, especially that this reference does not disclose the step (i) of treating the wafers in a bath with an aqueous O_3 solution only containing O_3 and optionally HF and, after having performed (i), the step (ii) of treating the semiconductor wafers in a bath with an aqueous HCl solution only containing HCl and optionally O_3. Since the other reference cited by the Examiner, *Pirooz et al.*,

also does not disclose (ii), it is immediately clear that even the combination of both documents, which is not even suggested by the prior art, does not lead to the claimed invention.

Therefore, it is the Applicant's position that the present claims are clearly patentable over the cited prior art.

Moreover, the Office Action takes the position that a person having ordinary skill in the art would have found it obvious to modify *Pirooz's* procedure by treating the semiconductor wafers with O_3 and then treating the wafers with a liquid containing HCl in a separate bath in order to produce a more efficient procedure for removing metals from the surface. However, such a procedure is not in compliance with the teaching of *Verhaverbeke et al.* This teaching comprises directly displacing the volume of the first reactive process fluid by providing a second reactive process liquid (See.col.16, lines 41-43).

If the Examiner's suggestion is true that a person having ordinary skill in the art would have found it obvious to modify *Pirooz* by eliminating the step of rinsing with water as taught by *Verhaverbeke et al.* in order to obtain good process performance, then consider the following. Why should this person at the same time adhere to the *Pirooz's* teaching of using separate treatment

baths which probably impairs the process performance? Also consider why should this person modify the *Pirooz's* process by treating the semiconductor wafers with O_3 and then treating the wafers with a liquid containing HCl in a separate bath which certainly impairs the process performance (because a single step is split in two separate steps)?

In addition, why should a person having ordinary skill in the art have found it obvious to modify *Pirooz's* procedure by treating the semiconductor wafers with O_3 and then treating the wafers with a liquid containing HCl in a separate bath in order to produce a more efficient procedure for removing metals from the surface? This is because *Pirooz* actually teaches using ozone and HCl optionally, only (col.3, lines 32-34) It would appear that the Patent Examiner has based these conclusions on the present invention teachings by using hindsight.

Therefore, a person skilled in the art would have no motivation at all to combine the references in the manner as suggested by the Patent Examiner.

In addition, *Pirooz* in columns 2 and 3 teaches the following:

substances which are optionally present only are inclosed into brackets.

Step A:

$HF:H_2O$ + [HCl] or $HF:H_2O$ +-[H_2O_2] or $HF:H_2O$ + [O_3]

Step B:

Rinsing with H_2O

Step C:

$O_3:H_2O$ + [HCl] or $O_3:H_2O$ + [HNO_3]

Step D:

Rinsing with H_2O

The reference *Verhaverbeke et al (US-6,132,522)* teaches, inter alia, a sequence of the following treatment agents (please see column 9, lines 34-42):

Step 1:

$HF:H_2O$

Step 2:

$H_2O_2:H_2$:HCl

or

Step 3:

$H_2O_2:H_2O:NH_4OH$

Step 1:

H_2O_2: H_2O: NH_4 OH

Step 2:

H_2O_2: H_2O: HCl

Step 3:

HF: H_2O

In addition, according to *Verhaverbeke et al.* rinsing of the wafers between steps 1 to 3 is not required.

The present invention claims a procedure comprising a treatment with the following sequence of treatment agents:

Step i:

$HF:H_2O$ + [HC1] + [surfactant]

Step ii:

$O_3:H_2O$ + [HF]

Step iii:

$HC1:H_2O$ + [O_3]

Also any rinsing step between steps i to iii is excluded.

Since the last mentioned feature is a crucial requirement of the present invention, *Verhaverbeke et al.* clearly qualifies to be considered as the closest prior art reference.

A comparison between *Verhaverbeke et al.* and the present invention reveals a significant difference between steps 2 and 3 (*Verhaverbeke*) and steps ii and iii (Invention) respectively. Step 2 and step ii differ in that H_2O_2:H_2O:HCl(prior art)is used instead of O_3:H_2O (Invention) and step 3 and step iii differ in that H_2O_2:H_2O:NH_4OH (prior art) is used instead of HCl:H_2O(Invention).

If the present invention is further compared with *Pirooz et al.*, two other differences can be found. *Pirooz et al.* teach in contrast to both the present invention and *Verhaverbeke et al.* a rinsing step with water (step B) and *Pirooz et al.* discloses a step C comprising a treatment with either O_3:H_2O+[HCl] **or** O_3:H_2O+[HNO_3], whereas according to the present invention **two subsequent steps** are necessary, i.e. step ii (a treatment with O_3:H_2O+[HF]) and then step iii (a treatment with HCl:H_2O + [O_3]).

Verhaverbeke is not combinable with *Pirooz* for the following reasons.

Verhaverbeke U.S. Patent No. 6,132,522 in column 3 in lines 9 to 22 discloses wet processing methods useful in the manufacture of electronic component precurors, such as semiconductor wafers and flat panels, used in integrated circuits. These methods can be used for the cleaning, stripping, and/or etching of such electronic component precursors.

It has been discovered that eliminating the DI rinse between each chemical treatment step minimizes precipitation of the silica, metal, and/or oxide precipitates. In contrast to the wet processing methodologies available in the art, which focus on rinsing the electronic component precursors with DI water between each chemical treatment step, the process eliminates the need for the DI rinse by using a sequential chemical methodology.

In column 9 in lines 7 to 28 *Verhaverbeke* discloses that in sequential chemical processes, the DI rinse between each chemical step is not required. In a sequential chemical process the vessel fills with DI water through valve 31, conditioning of temperature and flow take place, the first reactive chemical process fluid is injected into DI water stream flowing in 9 via injection lines (i.e., 17, 15). The first reactive chemical flows into the vessel through valve 31 into the vessel. The soak starts by closing valve 31. During the soak, conditioning of

flow and temperature of DI water occurs through the DI bypass 45, by opening valve 47. Conditioning occurs only during the soak. At the end of the soak, the valves positions switch (i.e., valve 31 opens and 47 closes) and injection of the next reactive chemical process fluid occurs immediately through injection port 19 so that next reactive chemical process fluid directly displaces the previous reactive chemical process fluid (i.e., no DI water is used to displace chemical in the vessel). These steps or similar steps known to persons skilled in the art may be repeated until the electronic component precursors are properly treated with the appropriate chemicals. Following the chemical treatment steps, the electronic component precursors may be dried as discussed above.

In column 10 in lines 15 to 45, *Verhaverbeke* discloses that the methods of this reference may be used where only one set of sequential chemical treatment occurs. For example, where the chemical treatment recipe is sulfuric acid (mixed with either peroxide or ozone)/HF/SCI/SC2, this is followed by drying. Traditionally, a DI water rinse is performed between each chemical treatment step. According to the methods of this reference, all of the DI water rinses may be eliminated or maybe only one or two rinses may be done between some, but not all, of the chemical treatment steps regardless of the wet processing

technique employed.

As previously stated, traditional wet processing techniques use a DI water rinse between each chemical treatment step to prevent the chemicals from mixing with each other and to prevent contamination of one reactive chemical process fluid with another. *Verhaverbeke* departs from this principal, by not performing a DI water rinse between each chemical treatment step, while still obtaining good process performance and leading to overall cost efficiencies. However, in practicing the process of *Verhaverbeke*, it is desirable to exchange the chemical solutions regularly to achieve reproducible processing. It is particularly preferred that the chemicals be exchanged after one use, while traditionally, chemicals are used for extended use. Adequate performance may be obtained with extended use by spiking (i.e., adding chemical to the second bath) to maintain a relatively constant concentration and pH. This, however, is still more efficient than the traditional techniques that use a DI water rinse between each chemical treatment step. A person skilled in the art would therefore never combine the teaching of *Verhaverbeke* (devoid of water rinsing) with *Pirooz* (employs water rinsing).

R:\DonnaM\Brunner etal1\Brunner Response to FinalYES

It is clearly non-obvious to replace a single step treatment taught by a prior art reference as a treatment which can be realized by choosing one of two possibilities by a two step treatment requiring the two possibilities in a specific order. Moreover, it still must be emphasized that *Pirooz et al.* teach intermediate rinsing with water which is contradictory to the teaching of *Verhaverbeke et al.* Hence any attempt to combine these references would constitute a radical reconstruction of the prior art which is impermissible according to 35 U.S.C. 103.

Accordingly, both references absolutely cannot be combined so as to disclose the claimed invention.

Thus the claims must be considered as being non-obvious under 35 U.S.C. 103 with respect to the prior art applied by the Patent Examiner. A prompt notification of allowability is respectfully requested.

Respectfully submitted,

BRUNNER ET AL - 1 (CPA)

Allison C. Collard, ~~Reg.No.22~~,532
Edward R. Freedman, Reg.No.26,048
Attorneys for Applicant

COLLARD & ROE, P.C.
1077 Northern Boulevard
Roslyn, New York 11576
(516) 365-9802
ERF/dm

I hereby certify that this correspondence is being deposited with the U.S. Postal Service as first class mail in an envelope addressed to: Assistant Commissioner of Patents, Washington, D.C. 20231, on February 12,2003.

MARIA GUASTELLA